Electron Cooling Dynamics progress update
(December 15, 2003)
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Goals of the meeting

1. **Significant progress was made over the last six in code development. We started to study various cooling dynamics issues – we would like to get input on our present studies and understanding.**

2. **We would like to have a clear picture of most critical items which should be addressed over the next 6 month.**

Near term code developments and studies should be aimed towards definition of basic cooler parameters, with a CDR to be written during the summer of 2004.

A more detailed dynamics studies and benchmarking

of experiments will follow the CDR.

Progress summary

1. We went through summary points from our July's meeting. Also, we got V. Parkhomchuk (VP) input on these questions – next slides

2. Code development and benchmarking: Vorpal, SimCool and BetaCool – this morning

3. We started to study friction force with the Vorpal code – various regimes and various parameters – benchmarking with available formulas – this afternoon

4. We did some preliminary studies of cooling dynamics for RHIC and eRHIC using summer'03 version of BetaCool (many new developments since then) – tomorrow morning

5. Present study of cooling dynamics using SimCool and new features of BetaCool – tomorrow morning

6. We are discussing needed experiments for understanding of high-energy cooling and experiments which can be done in present coolers – collaboration with GSI-INTAS collaboration – tomorrow afternoon

Some of summary points from July's meeting and V. Parkhomchuk comments

1. **Differences between analytic formulas for the friction force (plasma-based vs. binary-collisions, Derbenev-Skrinsky, Derbenev-Skrinsky-Meshkov, Parkhomchuk, etc.)** – all of them have some problems - fail for some parameter range. This is why "empiric" formula was introduced. It works well for all parameters and was extensively benchmarked vs experiments – *benchmarking of various formulas and discussion of empiric formula will presented at this meeting.*

2. **More accurate analytic formulas (beyond Log approximation) are needed** – not really - cooling Log for parameters similar to RHIC is 2-2.5. Measurements for such Log's were done – good agreement with the formula – *present simulations with Vorpal seem to confirm this.*

3. A more accurate ("detailed") treatment of IBS (Burov's formalism) – such analysis may allow more accurate description of ion distribution evaluation due to both IBS and Cooling – well known statement – no dramatic differences from standard approaches based on rms rates is expected – *this is presently under investigation, including studies of this effect in BetaCool; some experiments suggested.*

4. Magnetized cooling is much better than non-magnetized for RHIC parameters. Alternative ways of "solenoidal" focusing were suggested (Derbenev) – quadrupole focusing ("magnetized") - major problem will be alignment of such channel to a required level. It is not obvious whether cooling will be as effective as with real magnetized beam.

5. Dependence on Z^2 – deviation from Z^2 only for low velocities – yes, for high ion velocities relevant dependence is Z^2 – *not so in experiments (will be shown later) – could be related to Debye shielding and if so – not expected for RHIC regime – will be studied with Vorpal code.*

6. Various possibilities to obtain lower transverse temperature of electron beam were discussed – **not relevant - even if transverse temperature of electrons is increased from 400 eV to 1500 eV there will be still effective cooling** – *studies of these effects including "bad magnetization" will be reported.*

7. Other alternatives cooling schemes besides electron linac were discussed – **alternative based on electron ring with 55 MeV was considered before (by VP et al.) is not expected to work** – *presently, we are concentrating on the baseline approach.*

8. Cooling solenoid will consist of two counter solenoids – **not a good idea since effective cooling will be reduced.**

Code development

- **Three codes are presently being developed to address electron cooling at RHIC:**

1. **Vorpal code (Tech-X, Colorado)**

   direct numerical simulation of the friction force

   usage:
   1. Benchmarking of available formulas for Cooling force.
   2. Study dependence of Cooling force on various parameters.

2. **BetaCool code (Dubna, Russia)**

3. **SimCool code (BNL's version)**

   usage:
   Cooling dynamics studies, including various effects.